

**DC:**

**X<sup>1</sup>**

**8**

# Numerical Notations

**Unclassified**

**2 Hour Conference, W/ 2Hr PE<sub>3</sub>**

**Safety & Environmental Impact is  
“LOW”**

**X<sup>18</sup>**

**Engineer Notation**

# Terminal Learning Objective

**ACTION:**

Calculate addition, subtraction, multiplication, and division problems using numerical notation and prefixes.

**CONDITIONS:**

Given a classroom environment, calculator, and official OMEMS references.

**STANDARD:**

Be able to find the value of a number using exponents, convert positive and negative whole numbers to powers of ten, convert powers of ten to prefix values, and correctly solve numerical notation and prefixes math problems to the established standard of 7 correct answers out of 10 & 8 out of 10 for EOD.

# Introduction

The Applied Physics commonly referred to as Electronics has numbers that are very large or very small. A convenient method of expressing these numbers is the standard of expression & communication that defines the quantities of Voltage, Current, Resistance and the size of the associated components & terms.

X<sup>18</sup>

**DC:**

# Exponents

**X<sup>1</sup>**

8

**EXPONENTS:** Provide a convenient method of writing or expressing many mathematical equations.

The Exponent tells us what to do to the Base Number.



The Exponent tells us how many times to Multiply the Base Number by itself.

$$2^4 = 2^1 \times 2^2 = 4^3 = 8^2 = 16 \quad [2 \text{ times itself, } 4 \text{ times}]$$

Exponent; Pwr of  
10

# DC: Exponents & The powers of 10 $\times 10^1$

8

Once again, The Exponent tells us how many times to Multiply the Base Number by itself.

Or W/ the Powers of 10, the Exponent tells us how many Places to move the Decimal, or Zeros to add.

$$10^3 = 10^1 \times 10^2 = 100 \times 10^3 = 1000$$

O  
R


$$10^3 = 1 \overset{1}{0} \overset{2}{0} \overset{3}{0} .$$

[Exponent tells how many places, or 0's]

# DC: Exponents & The powers of 10 $\times 1$

8

$$10^0 = 1.$$

$$10^1 = 10.$$

$$10^2 = 10 \times 10 = 100.$$

$$10^3 = 10 \times 10 \times 10 = 1000.$$

$$10^4 = 10 \times 10 \times 10 \times 10 = 10,000.$$

$$10^5 = 10 \times 10 \times 10 \times 10 \times 10 = 100,000.$$

$$10^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1,000,000.$$

The Exponent tells us how many places the Decimal moves or Zeros to add.

**JOB 1:** Solve for the Value of the base number & Exponent

a.  $3^3 = 27$

b.  $25^4 =$

c.  $9^6 =$

d.  $12^2 =$

e.  $6^5 =$

f.  $11^3 =$

g.  $14^3 =$

h.  $20^3 =$

i.  $10^4 =$

j.  $10^6 =$

$3 \times 3 \times 3 = 27$

OR, on the  
calculator: $3^3$ Calculator  
Keys

Answers Job 1

# DC: Exponents & The powers of 10 $X^1$

8

Converting a whole Number to a Power of ten, Move the decimal to the left.

The number of **places moved** is reflected in the **Exponent** of the Power of ten.

The diagram illustrates the conversion of the number 1.00 to a power of ten. On the left, the number 1.00 is shown with a vertical line indicating the decimal point. A blue arrow points left from the decimal point, labeled "Left 2 places". A black curved arrow points from the original number to the result. In the center, the expression  $1 \times 10^2$  is shown. To the right, another expression  $=$  is followed by a vertical line. A blue curved arrow points from the result to this second expression. Below the second expression, a black arrow points right, labeled "2 places Right".

$$1.00 = 1 \times 10^2 =$$

Left 2 places      2 places Right

Converting a Power of Ten back to a whole Number the process is reversed.

The Exponent will dictate the number of places the decimal will be moved to the Right.

Examp

e

# DC: Exponents & The powers of 10 $\times 10^1$

8

Converting Whole No. to a Power { Pwr. } of Ten, allows us to conveniently handle very large No.

$$6,250,000,000,000,000,000. = 6.25 \times 10^{18}$$

**Note:** The decimal was moved 18 places to the left and the Exponent reflects the No. of places moved, in the Pwr of 10.

$6.25 \times 10^{18}$  = No. of electrons  
passing a fixed point,  
in 1 second .

+ Number

Line

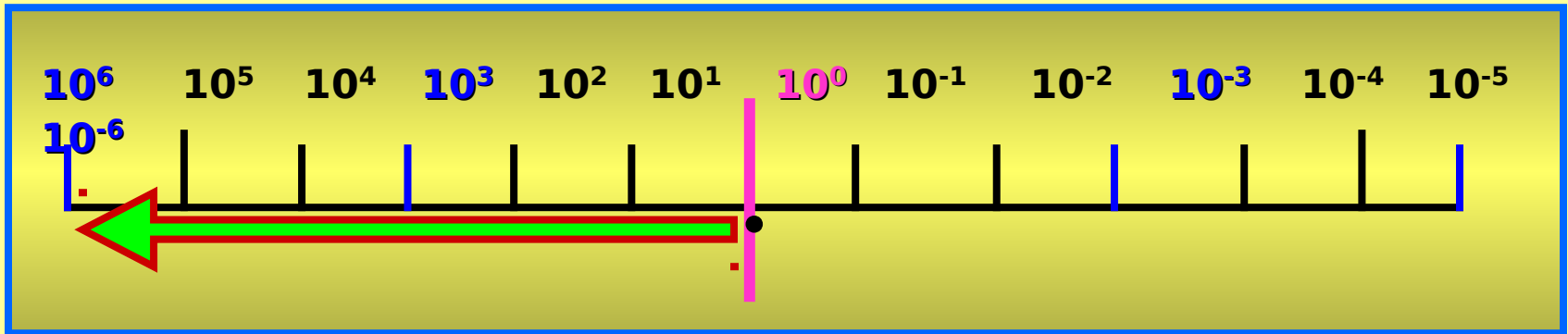
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# DC: Exponents & The powers of 10 $\times 10^8$

8

## NUMBER LINE USAGE:

Reference; Yellow Training Aid

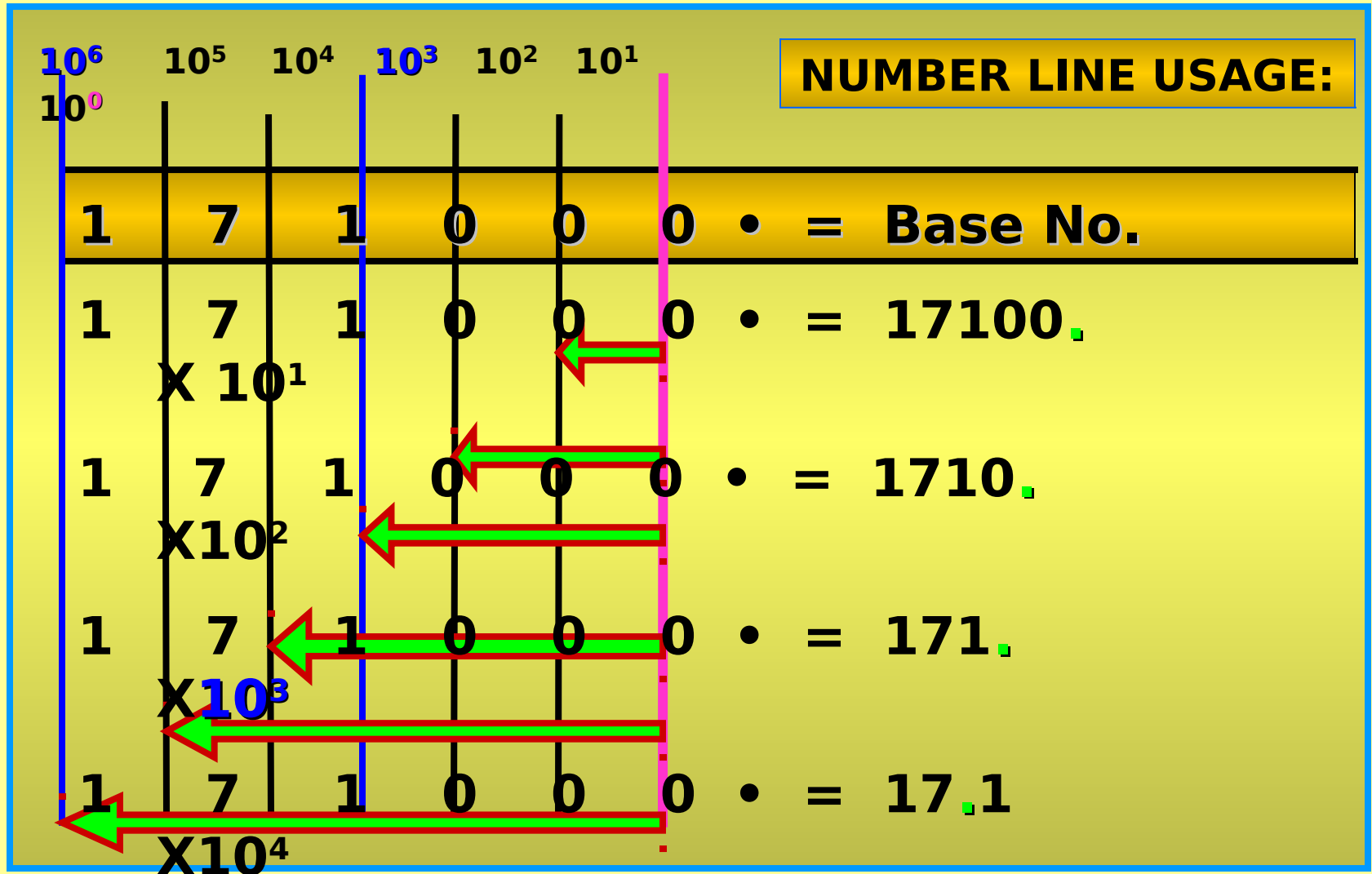


1. A Whole No. is placed on the Positive side and the decimal reference on  $10^0$ .
2. As the decimal is moved **LEFT**, the Exponent in the Pwr of 10 is Increased.

Number Line

# DC: Exponents & The powers of 10 $\times 10^1$

8



1 7 1 0 0 0 • = 1.71 X

$10^5$

Job; 2 &

3

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**JOB: 2****Convert Pwr of 10, to a Whole Number.**

a.  $5.45 \times 10^2$   
=

b.  $.1 \times 10^3$   
=

c.  $1.71 \times 10^3$   
=

d.  $10 \times 10^5$   
=

e.  $2 \times 10^6$   
=

f.  $13 \times 10^2$   
=

g.  $23 \times 10^4$

**545.**

Roll the **decimal**  
**2 places to the**  
**right**, as  
indicated by the  
exponent.

OR

5.45 EE 2 =

545.

5.45

545.

 $\times 10^2$ 

=

**DC:****Problem Sheets****X<sup>1</sup>**

8

**JOB: 3****Convert Whole Number, to a Pwr of 10,.**

a. 5,340 = **5.34** X 10<sup>3</sup>

X 10<sup>3</sup>

b. 145,000 =

X 10<sup>2</sup>

c. 170 =

X 10<sup>1</sup>

=

X 10<sup>3</sup>

d. 345 =

X 10<sup>6</sup>

=

X 10<sup>6</sup>

e. 13,100 =

X 10<sup>4</sup>

=

f. 2,000,000 =

X 10<sup>3</sup>

=

X 10<sup>3</sup>

g. 2,340,000 =

=

The **decimal** is  
**rolled LEFT** as  
indicated by the  
Exponent.

5 | 340. = 5.34

**Answers 3**

# DC: Exponents & The powers of 10 $\times 10^1$

8

Converting a Fraction, to a NEGATIVE Pwr of 10, the Decimal is moved RIGHT and is indicated in the exponent of the Pwr of 10.

$$\overset{1}{.}\overset{2}{0}\overset{3}{0}1 = 1. \times 10^{-3}$$

to the Right

Decimal; 3 Places

Converting a NEGATIVE Pwr of 10, to a Fraction, the Decimal is moved LEFT as is indicated in the exponent of the Pwr of 10.

$$1 \times 10^{-3} = \overset{3}{1}.\overset{2}{0}\overset{1}{0}1$$

LEFT

Decimal; 3 Places to the

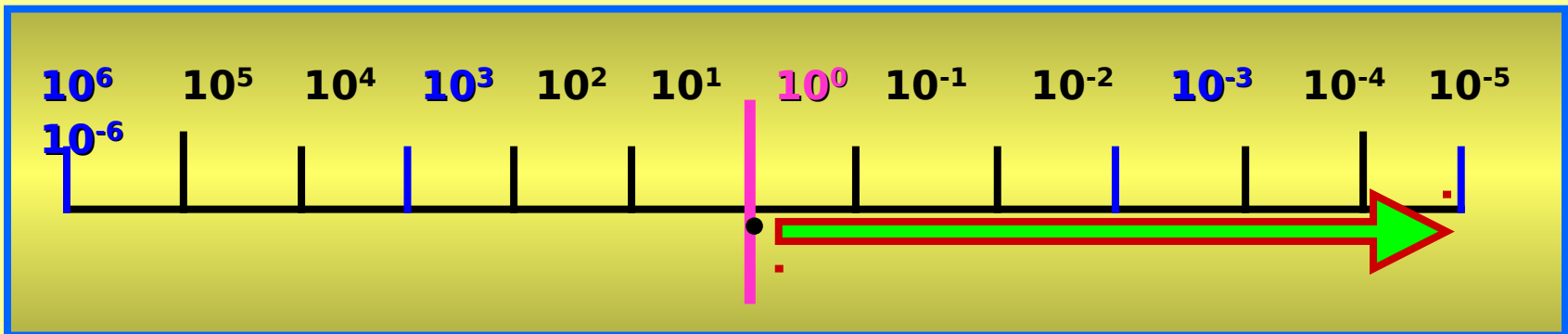
Number Line

# DC: Exponents & The powers of 10 $X^1$

8

## NUMBER LINE USAGE:

Reference: OMEMS Yellow Training Aid



1. A Fraction is placed on the **NEGATIVE** side and the decimal reference on  $10^0$ .
2. As the decimal is moved **RIGHT**, the Exponent in the Pwr of 10 is Decreased.

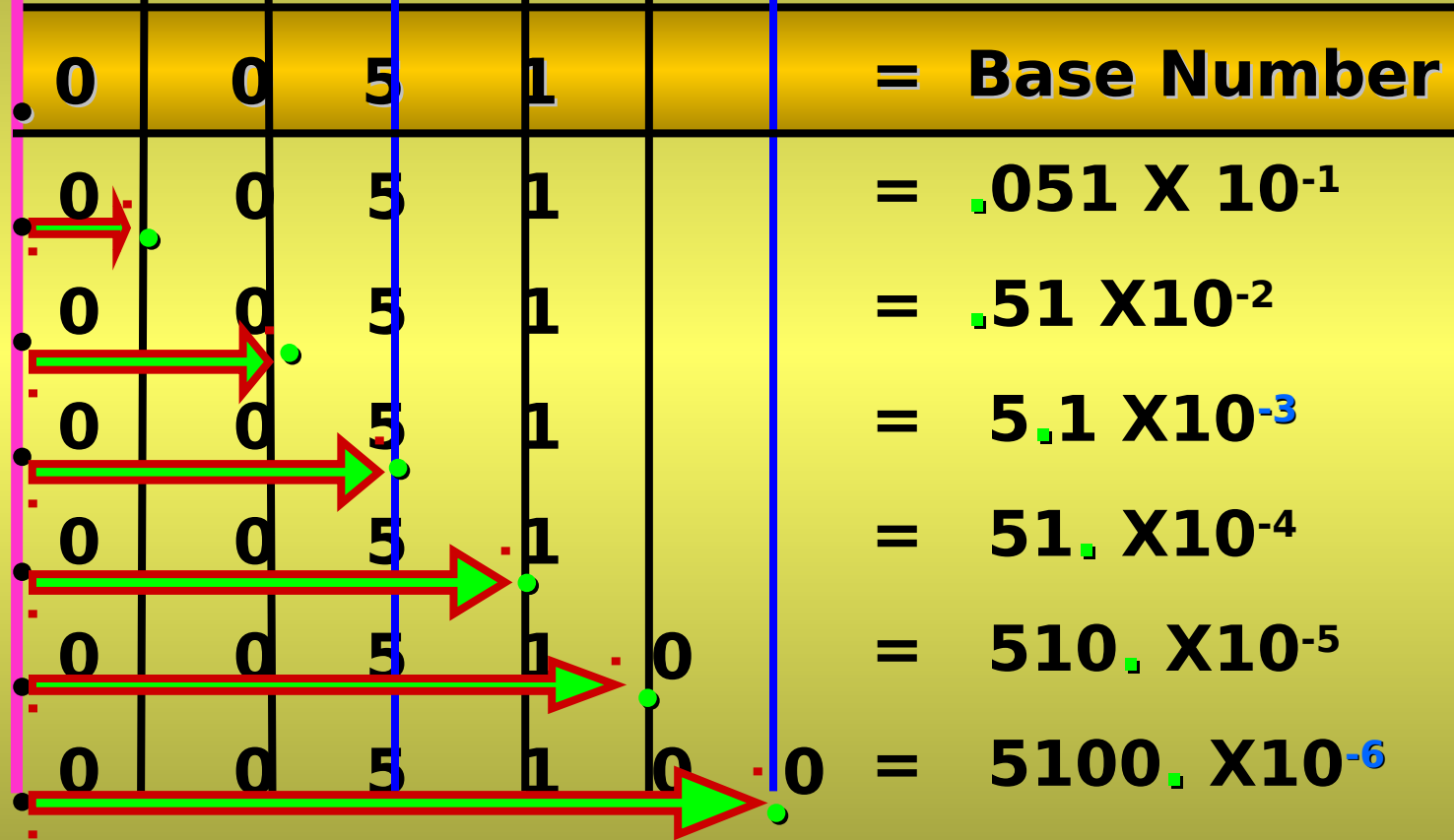
Number Line

# DC: Exponents & The powers of 10 $\times 10^1$

8

$10^0$   $10^{-1}$   $10^{-2}$   $10^{-3}$   $10^{-4}$   $10^{-5}$   
 $10^{-6}$

**NUMBER LINE  
USAGE:**

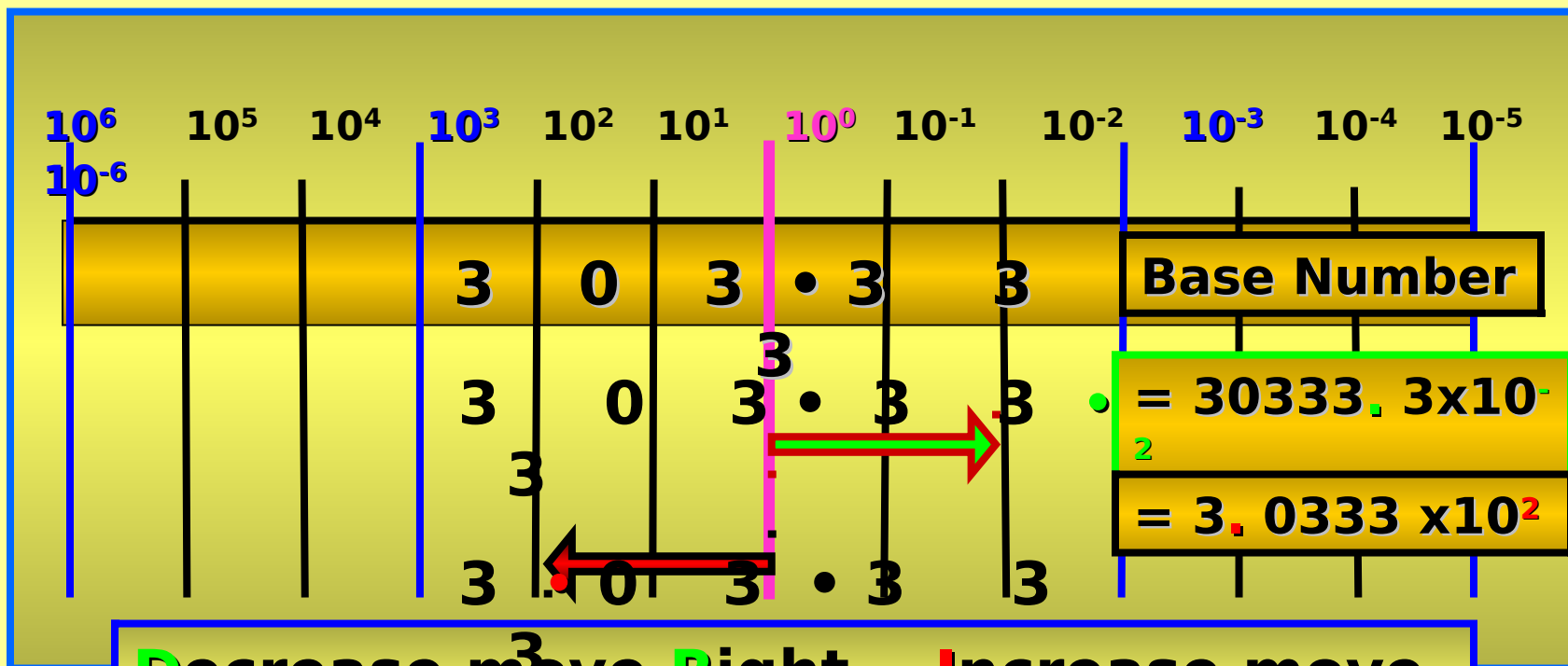


Number Line

# DC: Exponents & The powers of 10 $X^1$

8

A Whole No. & Fraction is placed with the decimal reference on  $10^0$ .



**Decrease move Right. Increase move Left.**

Reference: Yellow Training Aid

Job; 4 & 5

**JOB: 4****Convert Numbers to Negative Pwr of 10.**

a. .001 =  $\times 10^{-3}$

b. .00051 = <sup>1</sup>  $\times 10^{-6}$

c. .1101 =  $\times 10^{-2}$

d. .27 =  $\times 10^{-3}$

e. . =  $\times 10^{-5}$

000279 =  $\times 10^{-6}$

f. . =  $\times 10^{-4}$

000006

g. .0017 =  $\times 10^{-3}$

h. .012 =  $\times 10^{-2}$

i. .48 =  $\times 10^{-3}$

j. .0098

**Decrease  
move  
Decimal  
Right.**

**JOB: 5**

Convert Numbers to a Pwr of 10.

a. 4800 =  $\times 10^2$

b. .012 = <sup>48</sup>  $\times 10^{-2}$

c. .0017 =  $\times 10^{-4}$

d. 20500 =  $\times 10^2$

e. .000105 =  $\times 10^{-6}$

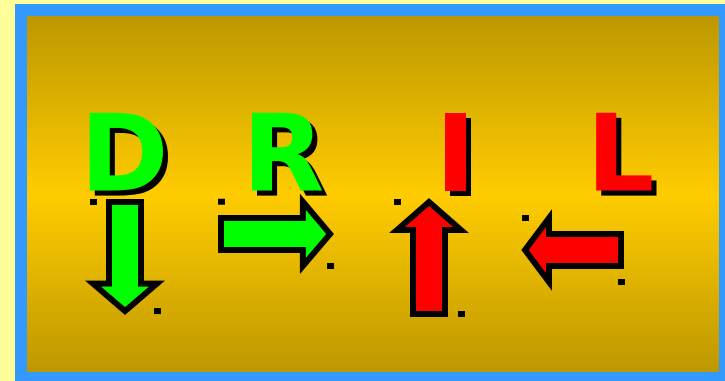
f. 330000 =  $\times 10^5$   
0 =  $\times 10^{-3}$

g. .0056 =  $\times 10^{-6}$

h. .00092 =  $\times 10^3$

i. 6500 =  $\times 10^4$

j. 740000



# DC: Addition of the Powers of 10

X<sup>1</sup>

8

When ADDING the Powers of 10 the Exponents must be the same.

The Exponent in the problem, will be the Exponent in the solution.

$$100 \times 10^3 + 5 \times 10^3 + 5 \times 10^3 = 110$$

On the

$$100 \text{ EE } 3 + 5 \text{ EE } 3 + 5 \text{ EE } 3 = 110000. = 110. \times 10^3$$

$$1.0 \times 10^{-3} + 5 \times 10^{-3} = 6 \times 10^{-3}$$

On the Calculator:

$$1 \text{ EE } 3 + 5 \text{ EE } 3 = .006 = 6. \times 10^{-3}$$

Exponent not  
same

DC:

## Addition of the Powers of 10

X<sup>1</sup>

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If the Exponents are NOT the same, in the problem, then @ least one of them must be changed so that all will be equal.

The Equal Exponents in the Problem, will be the Exponent in the solution.

$$10. \times 10^4 + 5 \times 10^3 + 5 \times 10^3 = \underline{\hspace{2cm}}$$

DR

$$100. \times 10^3 + 5 \times 10^3 + 5 \times 10^3 = \underline{\hspace{2cm}}$$

Note:  $10 \times 10^4$  is not the same, there for its exponent must be changed to equal  $\times 10^3$ .

$10^4$  must be **DECREASED by 1** to =  $\times 10^3$

The DECIMAL in  $10. \times 10^4$  is moved 1 place to the RIGHT.

Add; 2<sup>nd</sup>  
example

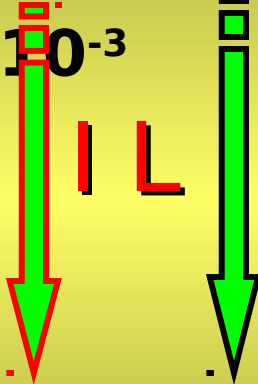
# DC: Addition & Subtraction; Powers of 10

8

Once again, If the Exponents are NOT the same, then one of them must be changed to be equal.

$$10. \times 10^{-4} + 5 \times 10^{-3} = \underline{\hspace{1cm}}$$

$\times 10^{-3}$



**INCREASE** from  $\times 10^{-4}$  to  $\times 10^{-3}$   
move the **DECIMAL LEFT**, one  
place.

$$1.0 \times 10^{-3} + 5 \times 10^{-3} = \underline{\underline{6}}$$

**SUBTRACTION; All rules apply as w/ Addition.**

# DC: Problem Sheets

X<sup>1</sup>

8

**JOB: 6**  
10.

**ADD Pwrs of 10; Put answers in a Pwr of**

a.  $7 \times 10^2 + 3 \times 10^2 = 10 \times 10^2$

b.  $6 \times 10^4 + 2 \times 10^3 = \underline{\hspace{1cm}} 10^3$

c.  $15 \times 10^1 + 75 \times 10^2 = \underline{\hspace{1cm}} 10^2$

d.  $27 \times 10^3 + 18 \times 10^2 = \underline{\hspace{1cm}} 10^3$

e.  $11 \times 10^5 + 23 \times 10^5 = \underline{\hspace{1cm}} 10^5$

f.  $35 \times 10^4 + 20 \times 10^2 = \underline{\hspace{1cm}} 10^2$

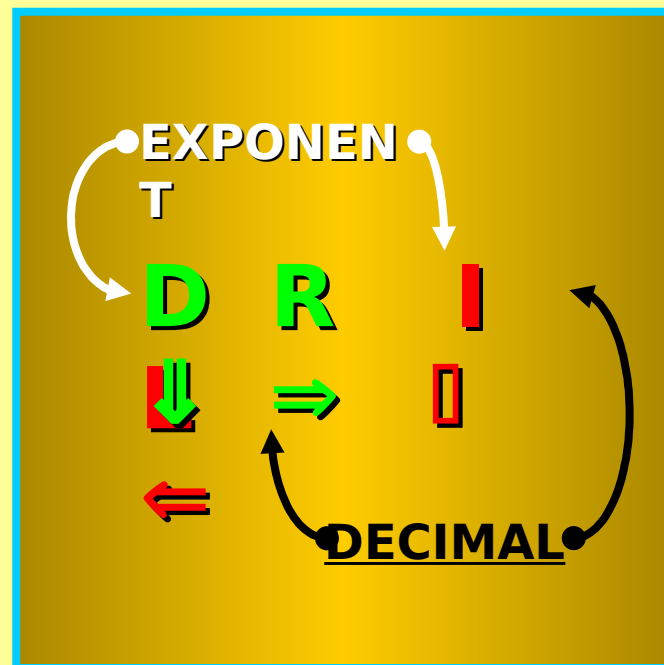
g.  $8 \times 10^5 + 3 \times 10^3 = \underline{\hspace{1cm}} 10^3$

h.  $\begin{array}{r} 12 \times 10^4 \\ + \\ 6 \times 10^3 \end{array} = \underline{\hspace{1cm}} 10^{-3}$

i.  $\begin{array}{r} 9 \times 10^2 \\ + \\ 5 \times 10^3 \end{array} = \underline{\hspace{1cm}} 10^3$

j.  $14 \times 10^3 + 1 \times 10^4 = \underline{\hspace{1cm}} 10^4$

**Exponents must be the same.**



Answers 6

**DC:****Problem Sheets****X<sup>1</sup>**

8

**JOB: 7**  
of 10.**SUBTRACT Pwrs of 10; Put answers in a Pwr**

a.  $16 \times 10^3 - 9 \times 10^3 = 7 \times 10^3$

b.  $75 \times 10^2 - 5 \times 10^3 = \quad \times 10^3 \quad 25 \times 10^2$

c.  $9 \times 10^4 - 4 \times 10^2 = \quad \times 10^4 \quad \times 10^2$

d.  $60 \times 10^3 - 5 \times 10^4 = \quad \times 10^3 \quad \times 10^4$

e.  $21 \times 10^5 - 21 \times 10^4 = \quad \times 10^4 \quad \times 10^5$

f.  $50 \times 10^3 - 2.5 \times 10^4 = \quad \times 10^3 \quad \times 10^4$

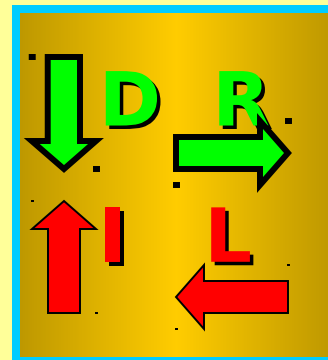
g.  $36 \times 10^4 - 10^4 = \quad \times 10^3 \quad \times 10^4$

h.  $42 \times 10^3 - 30 \times 10^3 = \quad \times 10^3$

i.  $33 \times 10^{-3} - 21 \times 10^3 = \quad \times 10^{-3}$

j.  $72 \times 10^{-3} - 3 \times 10^{-3} = \quad \times 10^{-4}$

j.  $72 \times 10^{-4} - 50 \times 10^{-4} =$

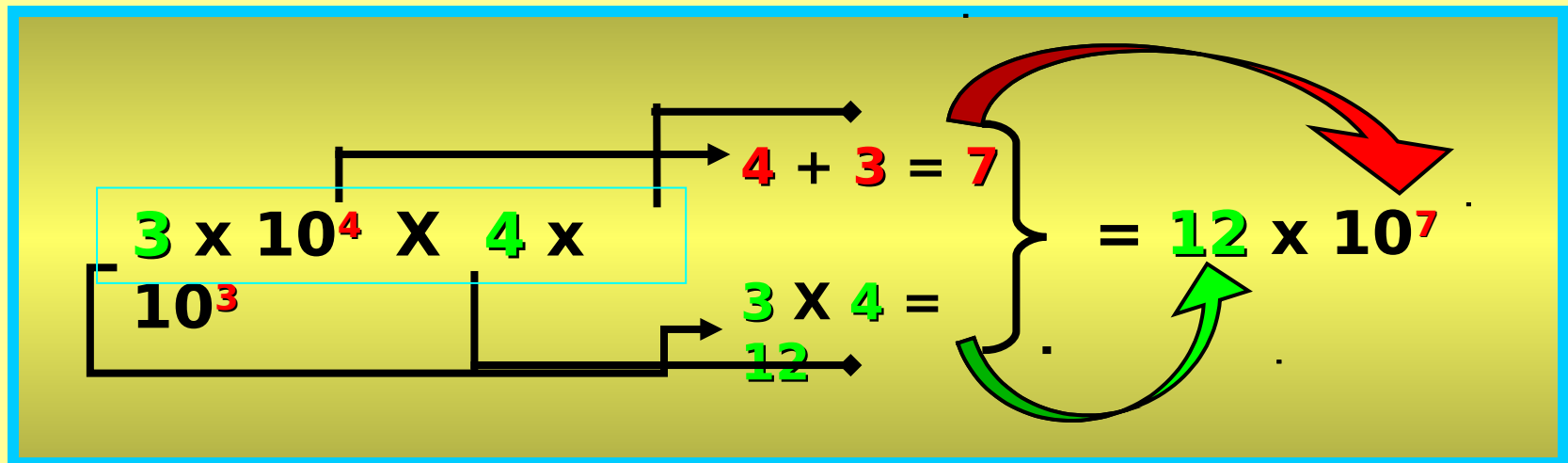
**Preferred  
Answers****Alternative****Answers 7**

# DC: Multiplication; Powers of 10

X<sup>1</sup>

8

**Multiplying the powers of 10, the Exponents must be added in the problem, to get the Exponent in the solution. PROVIDED the Polarities are the same.**



Multiply; W/+ &

DC:

# Multiplication; Powers of 10

X<sup>1</sup>

8

If the Polarities of the Exponents are not the same,  
Subtract the smaller exponent from the larger.

The polarity of the larger absolute number will be  
the polarity of the exponent in the solution.

$$3 \times 10^{-4} \times 4 \times 10^{-1}$$
$$4 - 3 = 1$$
$$3 \times 4 = 12$$
$$= 12 \times 10^{-1}$$

Multiply; 3<sup>rd</sup>

Example

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$$\mathbf{X}^1$$

Diagram illustrating the distributive property of multiplication over addition. The expression is  $5 \times 10^3 \times 3 \times 10^0$ . A bracket groups the  $3 \times 10^0$  part, which simplifies to 3. The main expression becomes  $5 \times 10^3 \times 3$ . A second bracket groups the  $5 \times 10^3$  part, which simplifies to 15. The final result is  $15 \times 10^3$ .

**If the Polarities of the Exponents are NOT the same, Subtract.**

**JOB: 8**

Multiply Pwrs of 10; put answers in a Pwr of 10.

- a.  $120 \times 10^4 \times 8 \times 10^3 = 960 \times 10^7$
- b.  $10 \times 10^3 \times 4 \times 10^3 = \text{---} \text{---}$
- c.  $5 \times 10^0 \times 4 \times 10^{-3} = \text{---} \text{---}$
- d.  $4 \times 10^3 \times 6 \times 10^2 = \text{---} \text{---}$
- e.  $7 \times 10^2 \times 3 \times 10^2 = \text{---} \text{---}$
- f.  $21 \times 10^3 \times 4 \times 10^{-3} = \text{---} \text{---}$
- g.  $36 \times 10^2 \times 3 \times 10^3 = \text{---} \text{---}$

**Polarity the same,  
Exponents added.**

**Exponents  
Polarities are  
NOT the same,  
Subtract.**

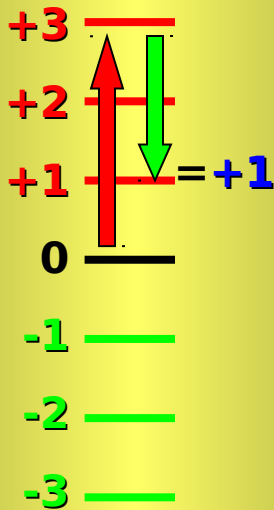
**DC:****Division; Powers of 10****X<sup>1</sup>**

8

**Division:** The polarity sign of the exponent divider, is changed, then Added to the exponent of the numerator, to provide the exponent for the solution.

**OR**

**\* Cross the Line, Change the Sign, then ADD.**



$$\begin{array}{r}
 4 \times 10^3 \\
 \hline
 2 \times 10^2
 \end{array}
 \rightarrow 4 \div 2 = 2$$

Diagram illustrating the division of powers of 10. The numerator is  $4 \times 10^3$  and the denominator is  $2 \times 10^2$ . The result is  $2 \times 10^1$ . The exponent of the denominator (2) is crossed out and its sign is changed to -2, which is then added to the exponent of the numerator (3) to get 1.

$$\begin{array}{r}
 4 \times 10^3 \\
 \hline
 2 \times 10^{-2}
 \end{array}
 \rightarrow 4 \div 2 = 2$$

Diagram illustrating the division of powers of 10. The numerator is  $4 \times 10^3$  and the denominator is  $2 \times 10^{-2}$ . The result is  $2 \times 10^5$ . The exponent of the denominator (-2) is crossed out and its sign is changed to +2, which is then added to the exponent of the numerator (3) to get 5.

**DC:****Problem Sheets****X<sup>1</sup>**

8

**JOB: 9**      **Divide Pwrs of 10; put answers in a Pwr of 10.**

a.  $\frac{16 \times 10^3}{4 \times 10^{-4}} =$

b.  $\frac{8 \times 10^5}{2 \times 10^2} =$

c.  $\frac{16 \times 10^2}{4 \times 10^3} =$

d.  $\frac{64 \times 10^4}{8 \times 10^2} =$

e.  $\frac{32 \times 10^6}{16 \times 10^3} =$

f.  $\frac{72 \times 10^5}{12 \times 10^{-3}} =$

g.  $\frac{24}{\frac{1}{12} \times 10^3} =$

h.  $\frac{24}{12 \times 10^3} =$

i.  $\frac{36 \times 10^3}{6 \times 10^2} =$

j.  $\frac{8 \times 10^4}{2 \times 10^3} =$

$\frac{21 \times 10^3}{21 \times 10^3} =$

**\* Cross the Line, Change the Sign, Then ADD.**

Answers 9

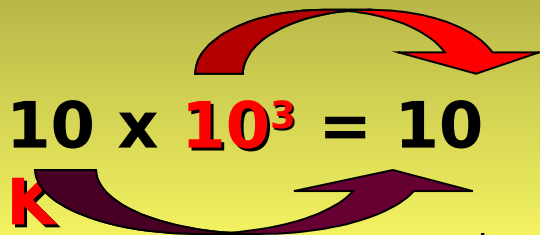
# DC: Powers of 10; To Prefix Values X<sup>1</sup>

8

Instead of expressing the electronic values in Numeric Notation, Pwrs of 10, all Numbers are standardized in the nearest increment of 3, and assigned an equivalent value letter.

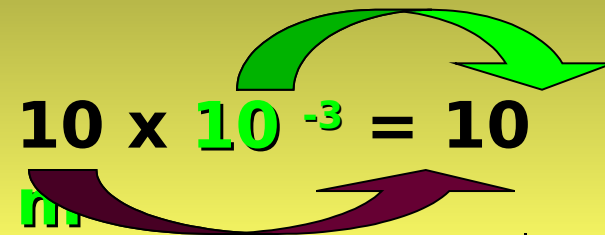
$$10 \times 10^3 = 10$$

K



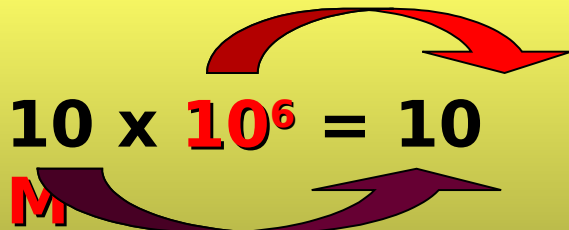
$$10 \times 10^{-3} = 10$$

m



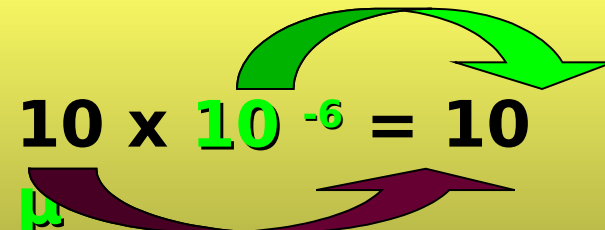
$$10 \times 10^6 = 10$$

M



$$10 \times 10^{-6} = 10$$

μ



Reference: OMEMS, Yellow Training Aid.

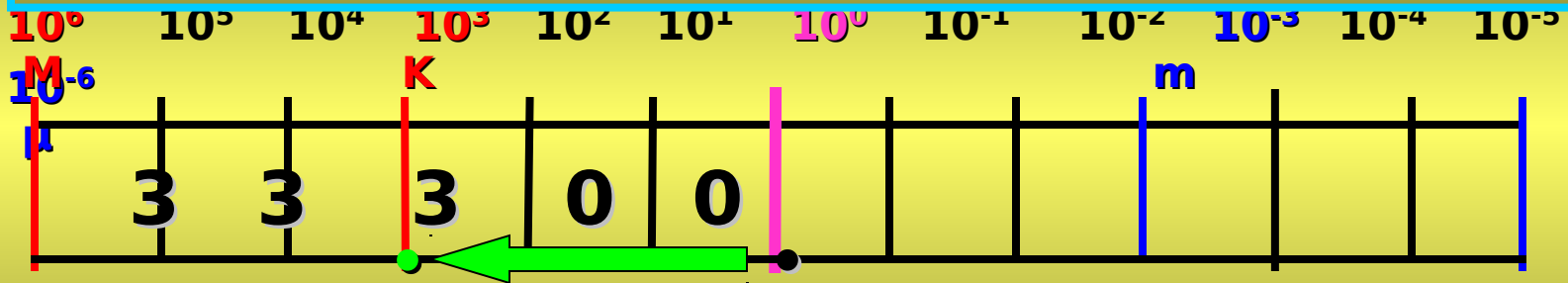
# DC: Powers of 10; To Prefix Values $X^1$

8

**Number Line Usage:** By placing a whole number on the number line, it can be converted to a prefix value.

**33,300.** Reference the Decimal on  $10^0$ .  
Move the Decimal 3 places to the  
**LEFT.**

The converted No. becomes; **33.3 K**



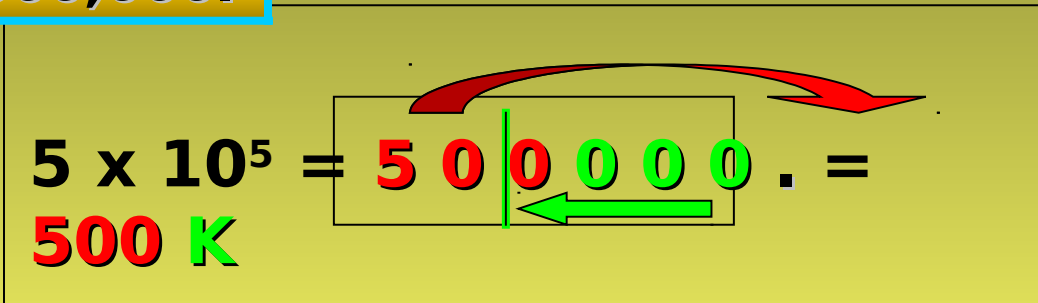
**Note:** Professional standard dictates that at least 1 whole  
+ No. be on the left of the decimal. [Engineer Notation]

Exempl

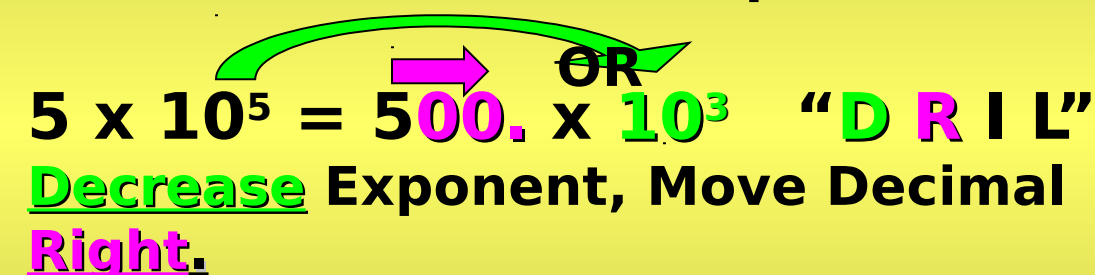
# DC: Powers of 10; To Prefix Values $X^1$

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Example: 500,000.


$$5 \times 10^5 = 500\,000. = 500 \text{ K}$$

Decimal rolled 3 places Left.


$$5 \times 10^5 = 500. \times 10^3 \text{ "D R I L"}$$

Decrease Exponent, Move Decimal Right.

The exponent was decreased by 2  
therefore the decimal is moved 2  
places.

$$\text{If; } 500. \times 10^3 = 500 \text{ K}$$

$$\text{Then; } 5 \times 10^5 = 500 \text{ K}$$

ADD

# DC: Powers of 10; To Prefix Values $\times 1$

8

**Problem solving,  
ADDITION:**

Long Hand:

$$\begin{array}{r}
 5K + 10M \\
 = \\
 5000. \\
 + 10,000,000. \\
 \hline
 10,005,000.
 \end{array}$$

$5K + 10M = 10005000.$  **M** =  $\times 10^6$ , roll 6 places Left  
 For **M**  $= 10,005,000.$   
 $10005000.$  Becomes  $10.005$  **M**

**On the  
CALCULATOR:**

$$5 \text{ EE } 3 + 10 \text{ EE } 6 = 10,005,000.$$

Is a whole number, roll the decimal **6** places **LEFT**, to

$$= 10.005\text{M}$$

6 5 4 3 2  
1 ←

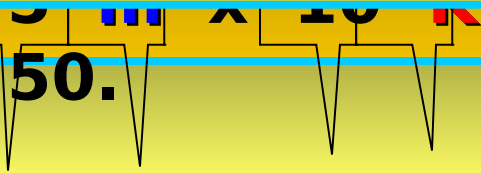
Multiply &  
Divide

# DC: Powers of 10: To Prefix Values $X^1$

8

Problem solving,  
Multiply:

On the  
CALCULATOR:



$$5 \text{ EE }^{-3} \times 10 \text{ EE }^3 = 50.$$

Is a whole number,

Problem solving,  
DIVIDE:

On the  
CALCULATOR:



$$5 \text{ EE }^{-3} \div 10 \text{ EE }^3 = .0000005 = .0005 \text{ m} = .5 \mu$$

whole number 3 to Right 6 to Right

$5 \mu$   $10^{-6}$   $[x 10^{-3}]$   $[x 10^{-6}]$

Chart

# DC: Powers of 10, To Prefix Values $X^1$

8

## Reference Chart:

| <u>Whole NUMBER</u> | <u>PWR of TEN</u> | <u>PREFIX</u><br><u>SYMBOL</u> |
|---------------------|-------------------|--------------------------------|
| 1 000 000 000.      | $10^9$            | Giga<br>G                      |
| 1 000 000.          | $10^6$            | Mega<br>M                      |
| 1 000.              | $10^3$            | Kilo<br>K                      |
| 1.                  | $10^0$            | -----<br>-                     |
| .001                | $10^{-3}$         | milli<br>m                     |
| .000 001            | $10^{-6}$         | micro<br>$\mu$                 |
| .000 000 001        | $10^{-9}$         | nano                           |

Job; 10 & 11

**DC:**

# Problem Sheets

**X<sup>1</sup>**

8

**JOB: 10, Convert Pwrs of 10; To a Prefix Value**

a.  $10 \times 10^3 =$

b.  $5 \times 10^4 =$

c.  $115 \times 10^5 =$

d.  $17 \times 10^3 =$

e.  $15 \times 10^{-3} =$

f.  $27 \times 10^{-6} =$

6

Answers 10

**DC:**

# Problem Sheets

**X<sup>1</sup>**

8

**JOB: 11, Solve the following problems, Answer in Prefix Value.**

a.  $5K + 7K =$

b.  $13K - 6K =$

c.  $2M + 2K =$

d.  $2m - 1m =$

f.  $5K =$

e.  $15\mu - 8m =$

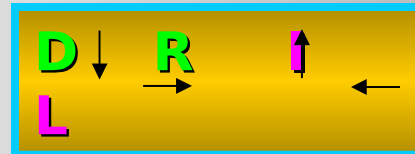
g.  $\frac{15}{M} =$

$\frac{1}{3K}$

h.  $5K \times 3K =$

i.  $2m \times 4m =$

j.  $11K \times 5K =$



Answers 11

# DC: Numerical Notation $X^1$

8

## SUMMARY & QUESTIONS:

### LESSON TEST:

**Time; 20 Minutes.**

**References; Yellow & Salmon,  
Training Aids.**

**Standard; 70% minimum.**

**[80%, EOD]**

# Engineer Notation